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United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

Prepared by the Defense Nuclear Agency as Executive Agency
for the Department of Defense

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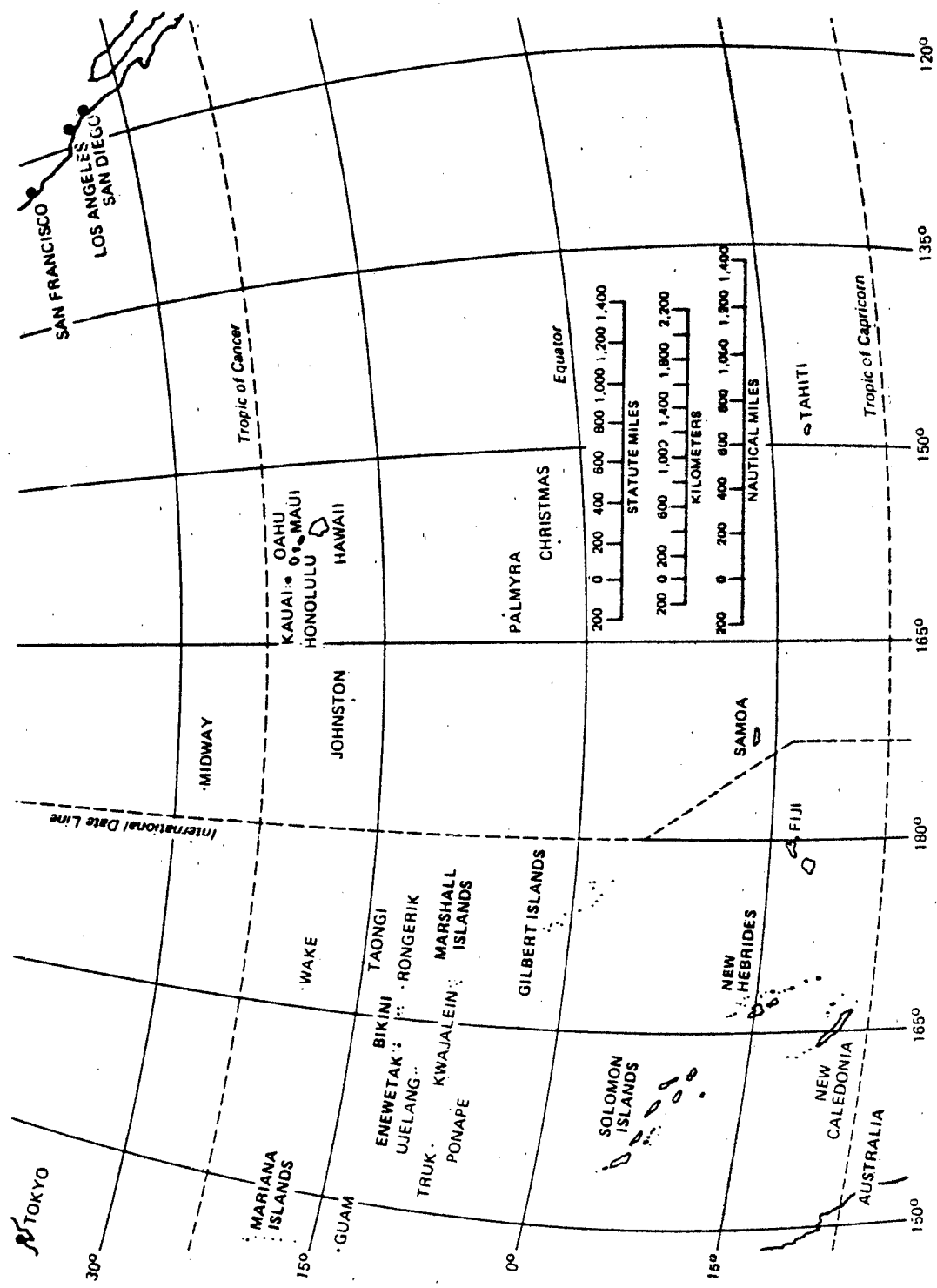


Figure 1. The Central Pacific.

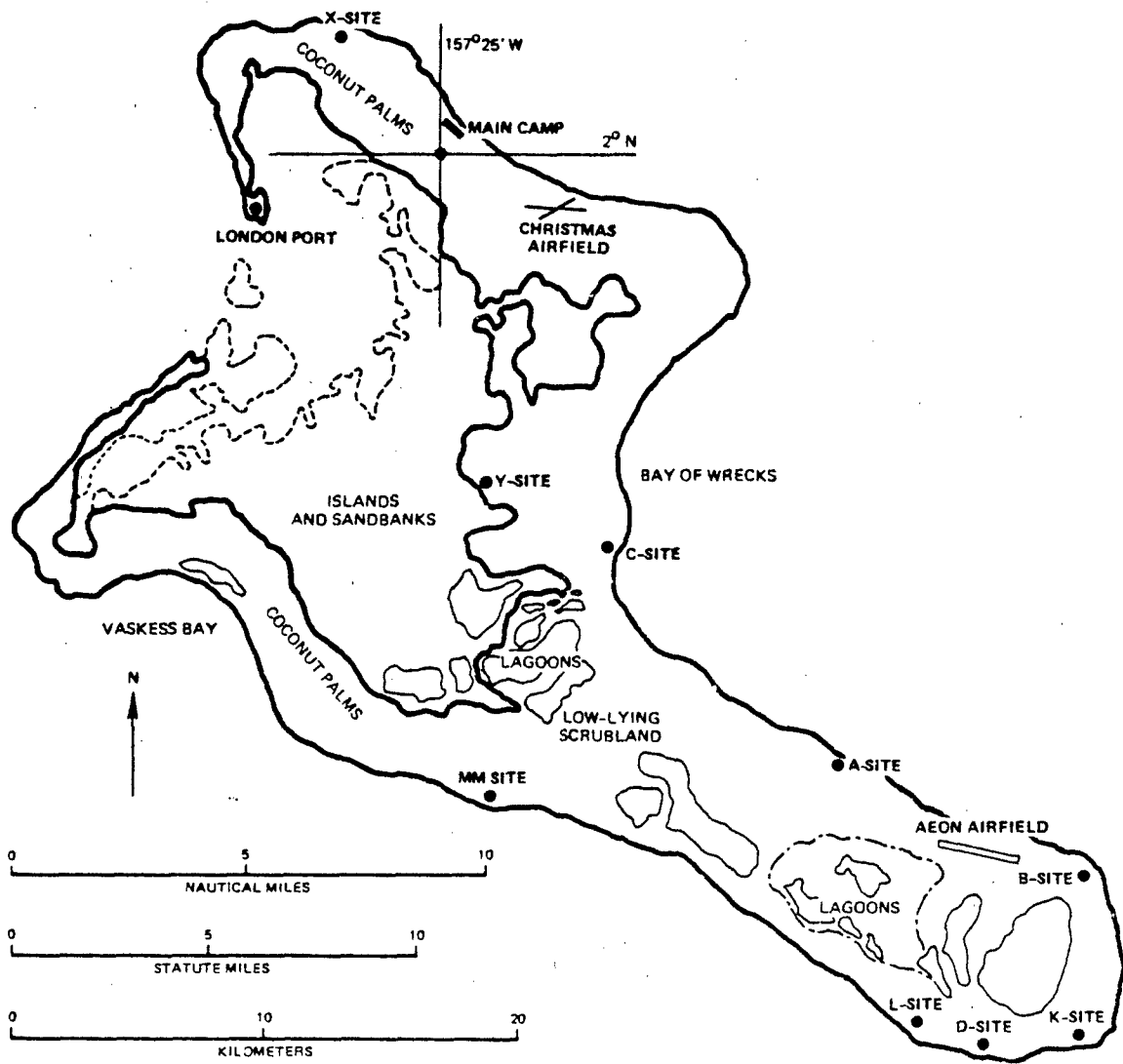


Figure 2. Christmas Island.

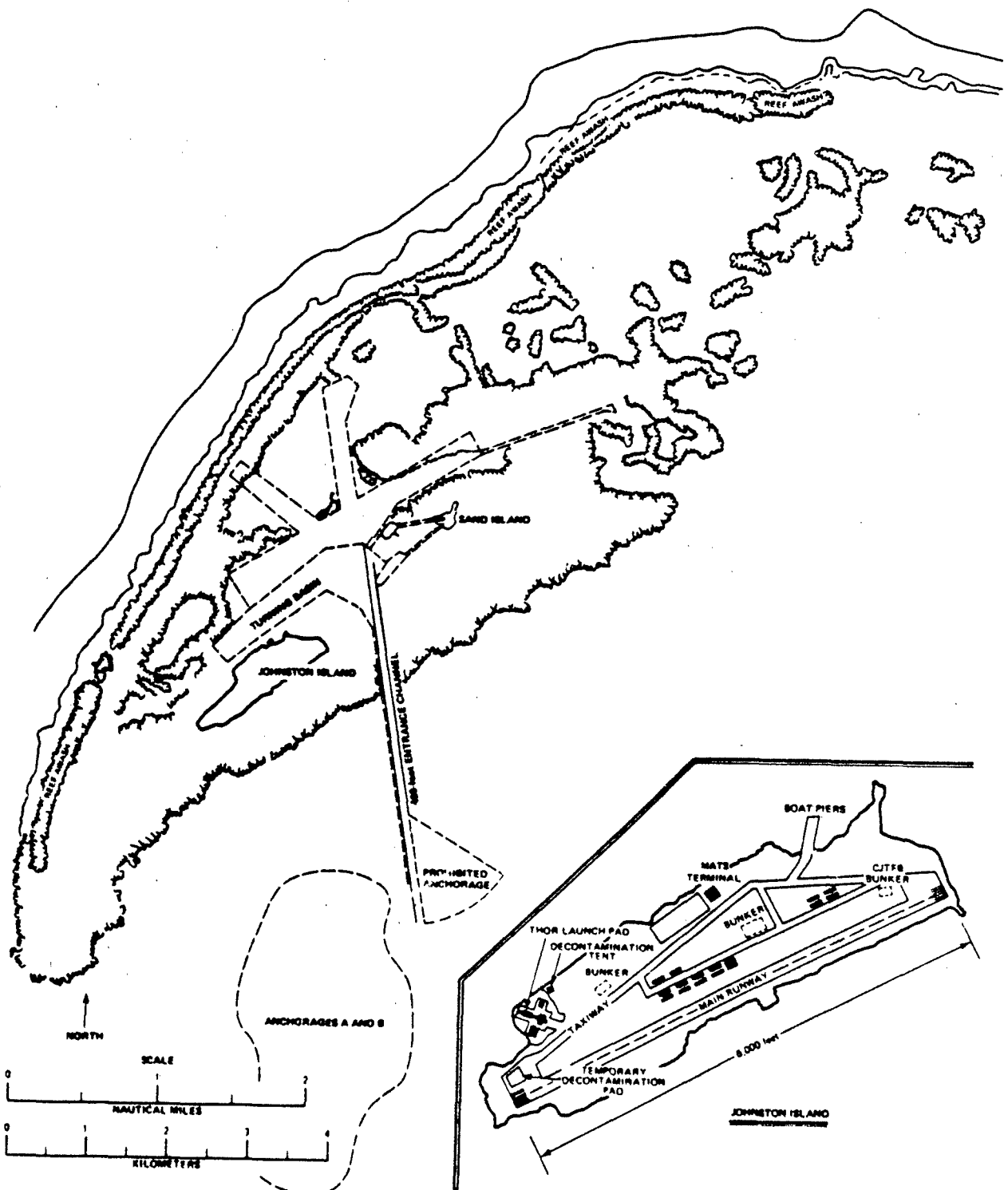


Figure 10. Johnston Atoll and Johnston Island, 1962.

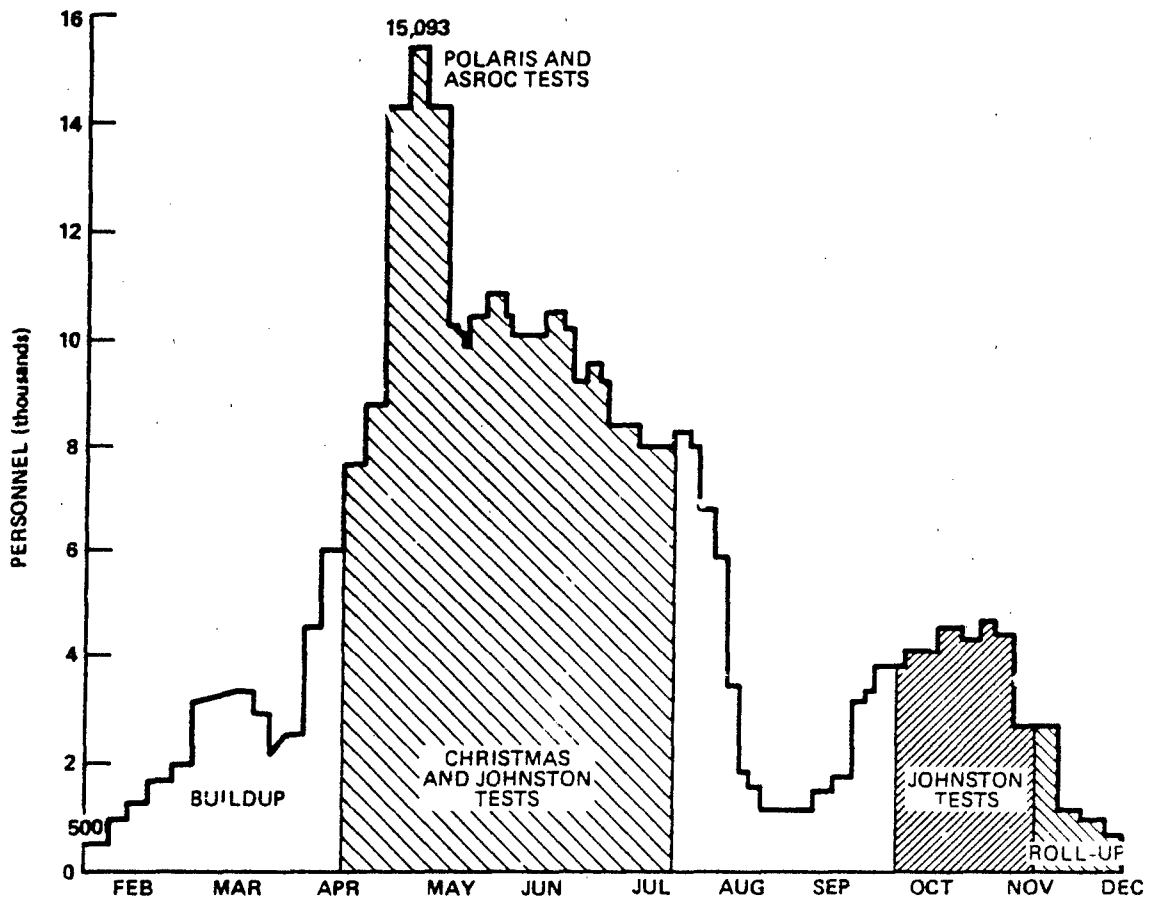


Figure 16. Joint Task Group 8.3 personnel participation during DOMINIC.

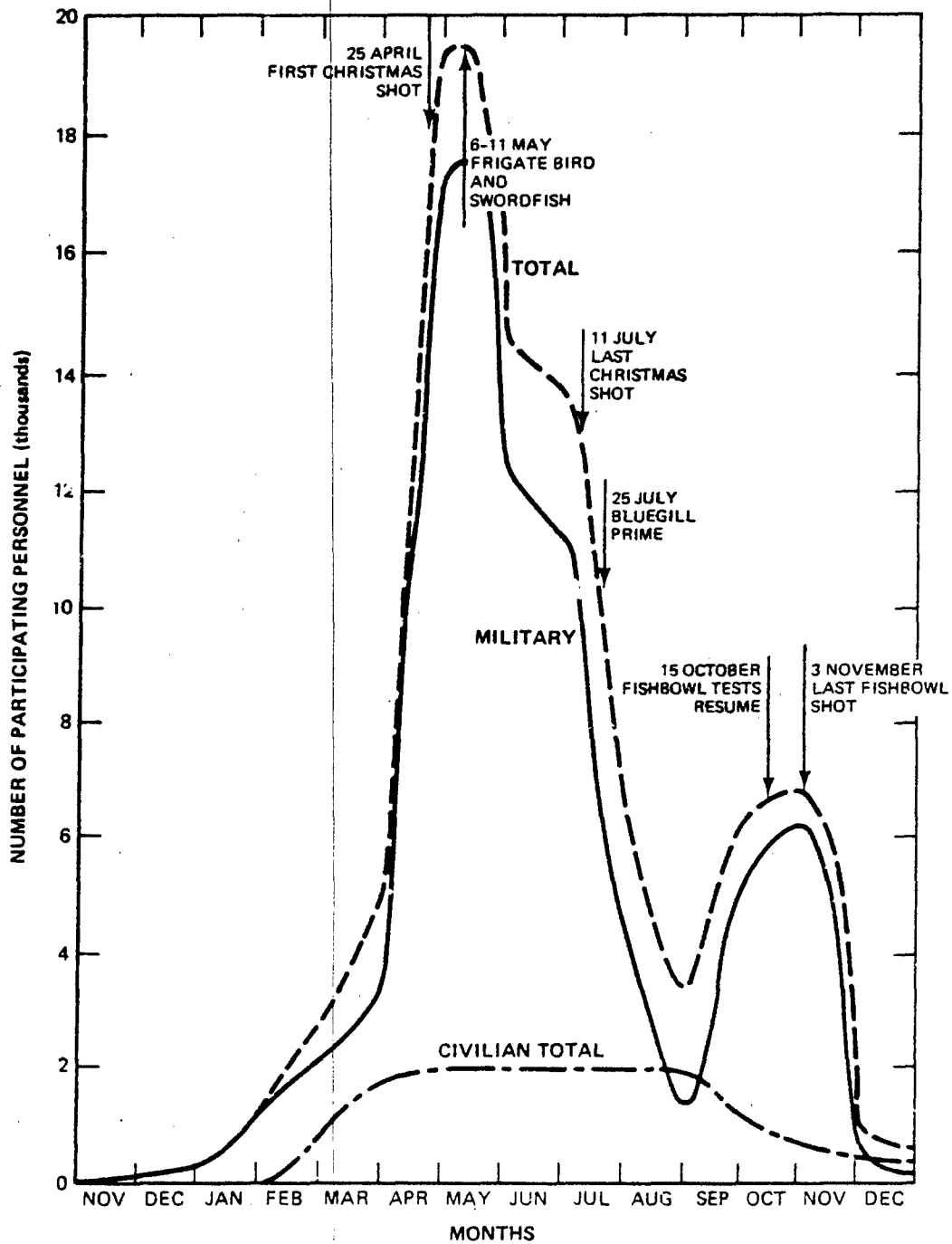


Figure 17. Joint Task Force 8 manning, DOMINIC.

Table 9. Average population at Johnston and Christmas islands during DOMINIC.

Period	Johnston Island	Christmas Island
12 - 31 Jan 1962	105	Note a
1 - 28 Feb 1962	151	Note a
19 - 28 Feb 1962	Note a	37
1 - 31 Mar 1962	360	460
1 - 30 Apr 1962	441	1,350
1 - 31 May 1962	535	1,769
1 - 30 Jun 1962	565	1,475
1 - 31 Jul 1962	520	685
1 - 31 Aug 1962	311	68
1 - 30 Sep 1962	483	18
1 - 31 Oct 1962	793	16
1 - 30 Nov 1962	378	15
1 - 31 Dec 1962	115	15

Note:

^aData not available.

Source: Reference C.I.I.

Table 11. Maximum Permissible Limit criteria for DOMINIC.

Personnel and Clothing	0.001 R/hr	(skin)
	0.002 R/hr	(underclothing)
	0.007 R/hr	(outer clothing)
Vehicles	0.007 R/hr ^a	(interior)
	0.007 R/hr	(outer surface measured at 5 to 6 inches)
Ships and Boats	No criteria for the operation. Decontaminate at the end of DOMINIC to 0.015 R/day (beta and gamma) and no detectable alpha. ^b	
Aircraft	0.007 R/hr	(interior)
	3 R/hr	(limit of cloud penetration for cloud-tracking aircraft)
Drinking Water	10 ⁻³ μCi/cc ^c	(beta/gamma emitters)
Air	10 ⁻⁷ μCi/cc	

Notes:

^a 0.005 R/hr if measured by AN/PDR-27J instrument.

^b Appendix 1, Annex J, Op Plan 2-62, paragraph 18(c) (reproduced in Appendix A of this report).

^c A microcurie (μCi) is a unit of radioactivity meaning 3.7 x 10⁴ disintegrations per second.

Source: Reference B.O.1, Annex J.

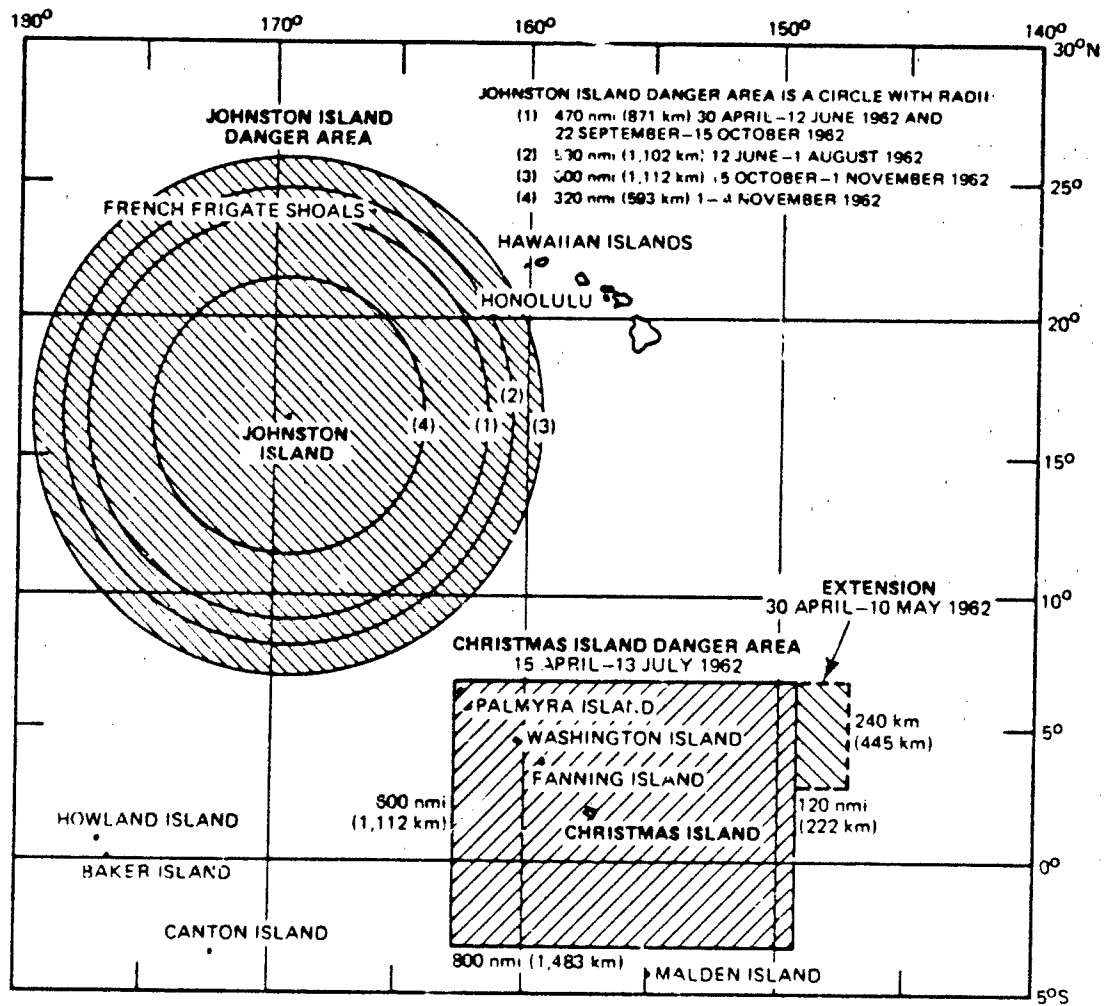


Figure 21. Christmas Island and Johnston Island danger areas, DOMINIC.

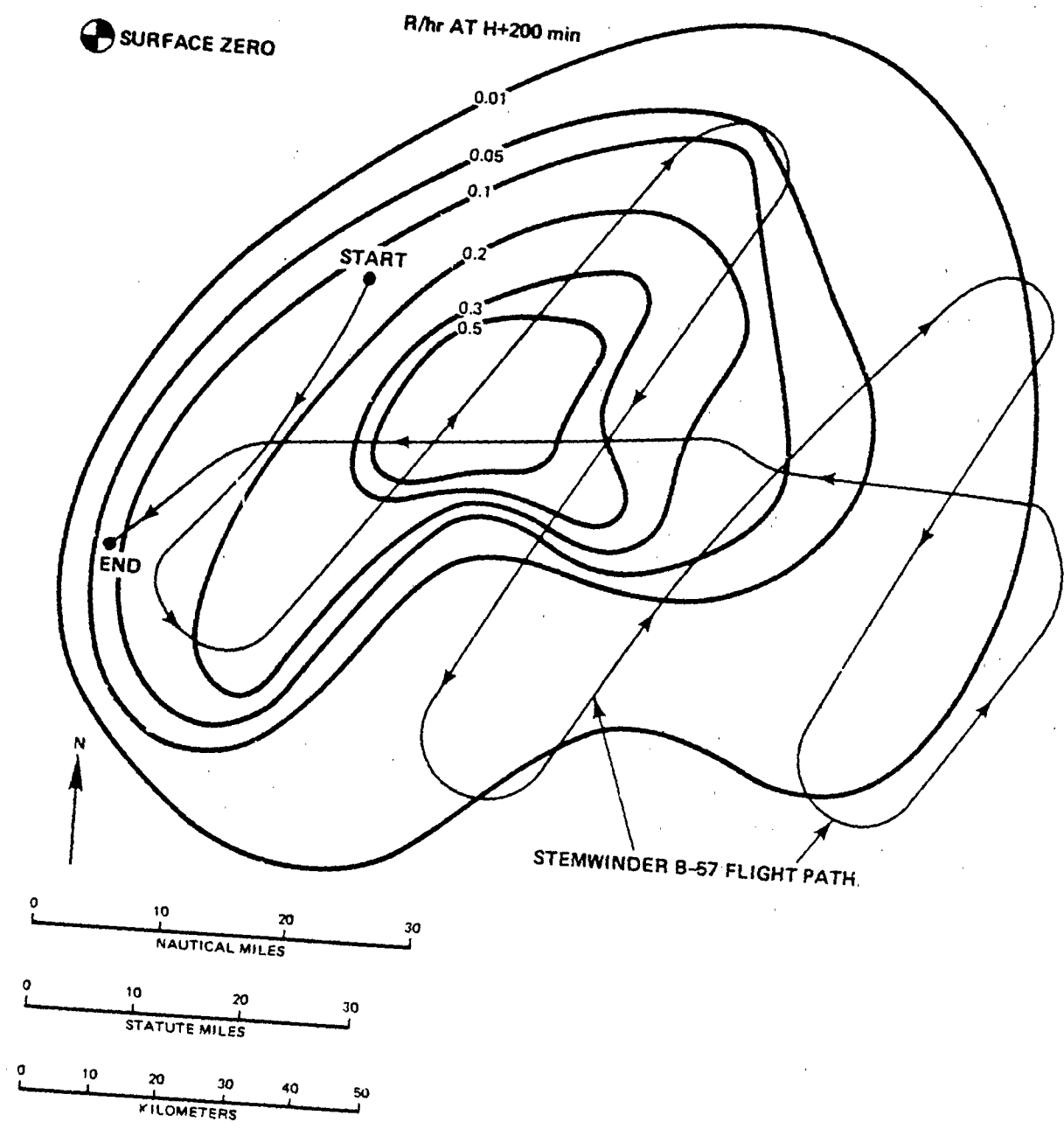


Figure 43. Sampling track and radiation pattern in the DOMINIC, BLUESTONE cloud at 45,000 feet (13.7 km) (source: Reference C.2060).

CHAPTER 5 FRIGATE BIRD

INTRODUCTION

The FRIGATE BIRD event was an operational test of the Polaris weapon system. The primary objective was to prove the system when fired by a regular crew under conditions similar to those that might be encountered in time of war. A secondary objective was to prove the weaponized warhead. The test was a first in several respects:

1. The first firing of a Polaris with a nuclear warhead
2. The first test of the Polaris nuclear weapon packaged as a warhead
3. The first detonation of a nuclear warhead after ballistic reentry into the atmosphere
4. The first operational test of a U.S. or Free World strategic nuclear ballistic missile weapon system.

At 1417 on 6 May 1962, the submarine, USS Ethan Allen (SSBN-608), launched the missile while submerged about 1,500 nmi (about 2,790 km) east-northeast of Christmas Island. The warhead traveled about 1,020 nmi (1,890 km) toward the island, detonating as an airburst.

Before this operational test of the Polaris weapon system, there had been a number of Polaris underwater missile launch tests off Cape Canaveral down-range into the Atlantic Ocean. More significantly, the first generation of Polaris submarines, consisting of five boats, had completed at least one Polaris patrol before the end of 1961.

The first second-generation Polaris submarine, Ethan Allen, was commissioned in August 1961. Following five successful test missile launchings and immediately before going to its first patrol, Ethan Allen was ordered to the Pacific Ocean to be the firing submarine in shot FRIGATE BIRD.

The FRIGATE BIRD event was the capstone on the proof of the Polaris missile system. The Polaris weapon system had joined the long-range manned bomber force and the land-based intercontinental ballistic missile force to form the three legs of the deterrent triad.

The exceedingly complex Polaris weapon system was conceived in the summer of 1957 and throughout the development period, all of its subsystems were tested separately and in various combinations. Only the FRIGATE BIRD event, however, offered the opportunity for a test of the Polaris system from launch through detonation.



Figure 76. FRIGATE BIRD cloud as viewed through the periscope of
USS Carbonero (SS-337), DOMINIC.

CHAPTER 6
SWORDFISH

INTRODUCTION

SWORDFISH, the fifth U.S. underwater nuclear test, was the detonation of a Navy nuclear antisubmarine rocket (ASROC). The ASROC is essentially a nuclear depth charge attached to a missile. On 11 May 1962, USS Agerholm (DD-826), steaming in an area about 370 nmi (about 685 km) west-southwest of San Diego, California, fired the ASROC at a target raft about 4,000 yards (3.7 km) distant. The target raft and the warhead detonated below the surface at 1302 local time, coordinates 31°14.7'N, 124°12.7'W.

Joint Task Group 8.9 (JTG 8.9), a subordinate organization of Joint Task Force 8 (JTF 8), conducted the SWORDFISH test. The task group was organized solely for the test, and it was made up of 19 ships, 2 submarines, some 55 naval aircraft, and 5,180 men, both civilian and military, drawn from the joint task force and other organizations as required (Reference C.I.D. p. B-2).

DEPARTMENT OF DEFENSE TASK GROUP SUPPORT

The Joint Chiefs of Staff (JCS) had directed the Commander JTF 8 (CJTF 8) to conduct an underwater nuclear weapon test using the ASROC, and he in turn had assigned the task to CJTG 8.3, the naval element of the joint task force. The staff of CJTF 8 did much of the initial planning for SWORDFISH. On 3 March 1962, CJTG 8.3 established Task Unit 8.3.4 (TU 8.3.4) to complete the planning for the test. JTG 8.9 was activated on 25 April as an additional command of CJTG 8.3. JTG 8.9 included all the JTG 8.3 assets assigned to the operation, plus elements of other commands as required (Reference C.I.D. p. B-6).

The organization of JTG 8.9, with participating units listed, is outlined below (Reference C.I.D. pp. B-4 through B-6 and B-12; Reference B.9, pp. 1-3):

- JTG 8.9 CJTG 8.3 in his role as CJTG 8.9
- TU 8.9.1 Operation SWORDFISH Test Directorate
- TE 8.9.1.1 VELA Project Elements: USS Tawakoni (ATF-114), USS Arikara (ATF-98), USS Lipan (ATF-85), USS Cree, USS Gannet (MSC-290), and Chilean ATF Yelco
- TE 8.9.1.2 Weather Reconnaissance Element: Patrol Squadron 46 (VP-46)
- TE 8.9.1.3 Technical Photography Element: Detachment 35, Heavy Photographic Squadron Sixty-Two; (VAP-62); Marine Aircraft Repair Squadron 37; (MARS-37); and TU 8.3.6 (Mobile Photographic Unit, Pacific)
- TE 8.9.1.4 Oceanographic Reconnaissance Element: USS Sioux and USC&GSS Pioneer

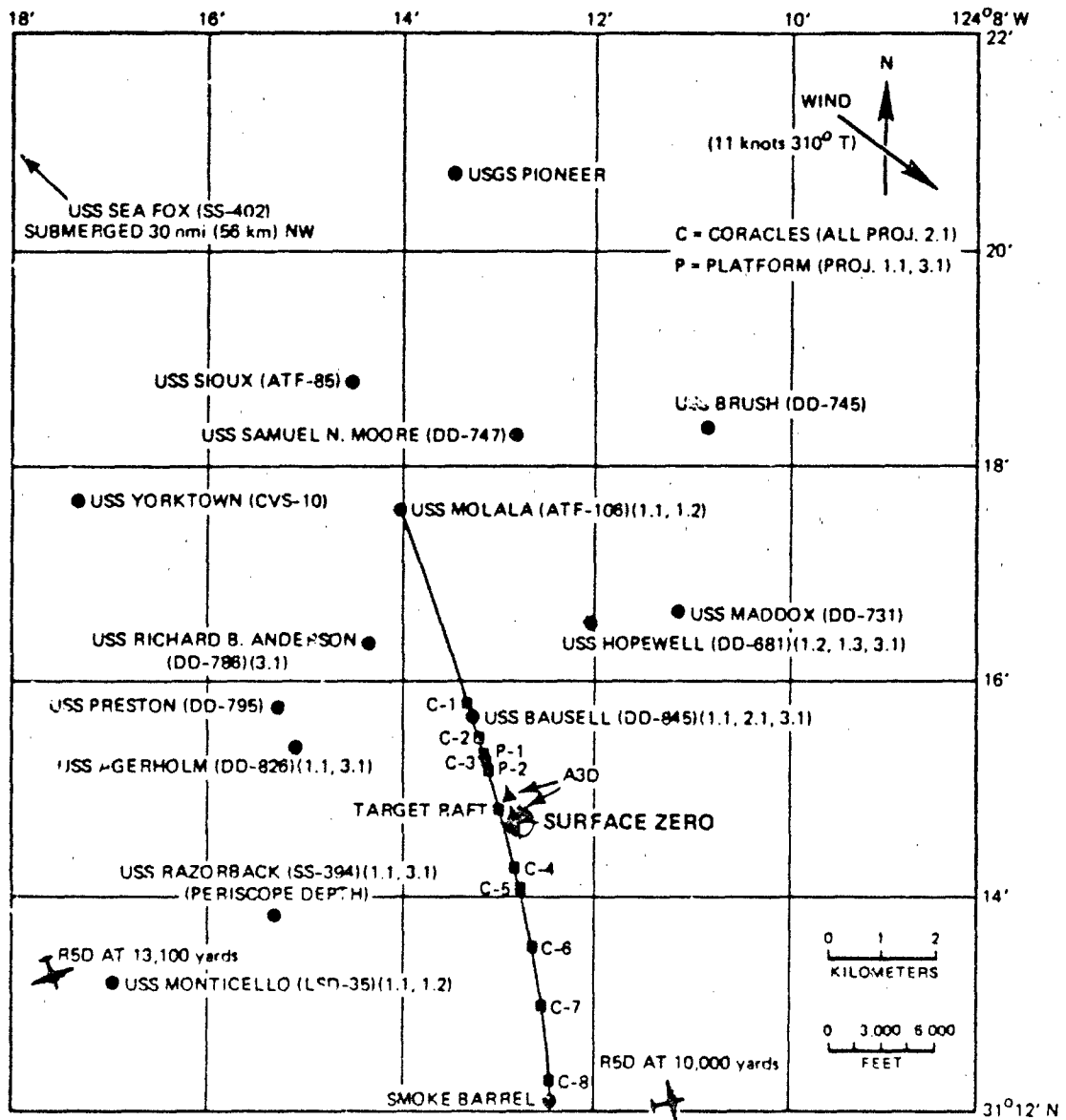


Figure 78. Positions of DOMINIC, SWORDFISH task group elements at shot time (source: Reference C.2007, p. 95).

Table 17. Positions of task group ships at shot time relative to surface zero, DOMINIC, SWORDFISH.

Array Element	Range ^a		Bearing (degrees)
	(yards)	(km)	
<u>USS Bausell</u> (DD-845)	2,200	0.671	338
<u>USS Agerholm</u> (DD-826)	4,348	1.325	298
<u>USS R.B. Anderson</u> (DD-786)	4,150	1.265	325
<u>USS Sioux</u> (ATF-75)	8,650	2.637	342
<u>USS Hopewell</u> (DD-681)	4,200	1.280	21
<u>USS Razorback</u> (SS-394)	4,600	1.402	251
<u>USS Monticello</u> (LSO-35)	7,940	2.420	250
<u>USS Molala</u> (ATF-106)	6,250	1.905	341
Platform 1 ^b	1,427	0.435	335
Platform 2 ^b	1,040	0.317	332
Target Raft ^b	348	0.106	306
Coracle 1 ^b	2,475	0.754	337
Coracle 2 ^b	1,771	0.522	337
Coracle 3 ^b	1,393	0.425	335
Coracle 4 ^b	810	0.247	181
Coracle 5 ^b	1,190	0.363	176
Coracle 6 ^b	2,297	0.700	171
Coracle 7 ^b	3,447	1.051	169
Coracle 8 ^b	4,930	1.503	168
Smoke Barrel ^b	5,230	1.594	167
<u>USCGC Pioneer</u>	12,600	3.840	356
<u>USS Preston</u> (DD-795)	4,700	1.433	300
<u>USS Yorktown</u> (CVS-10)	9,850	3.002	309
<u>USS Brush</u> (DD-745)	8,050	2.454	2
<u>USS C.M. Moore</u> (DD-747)	7,170	2.185	1
<u>USS Maddox</u> (DD-731)	4,800	1.463	36
Position buoy	3,120	0.951	126
Position buoy ^b	3,447	1.051	169
Position buoy	3,250	0.991	157

Notes:

^a Position determined by radar except as noted.

^b Position determined by aerial photography.

Source: Reference C.2007, pp. 97-98.

Table 18. Positions of aircraft relative to surface zero, DOMINIC, SWORDFISH.

Aircraft Type	Location Relative to Surface Zero
A30	Altitude 20,000 feet (6.1 km), heading 330°T, 3,200 feet (975 meters) beyond surface zero
A30	Altitude 20,000 feet (6.1 km), heading 330°T, 1,100 feet (335 meters) beyond surface zero
R50	Circular flight path; altitude 10,000 feet (3.0 km), 31,300 feet (9.54 km) horizontal range, bearing 150°T
R50	Circular flight path; altitude of 10,000 feet (3.0 km), 35,700 feet (10.89 km) horizontal range, bearing of 250°T

detonation, was about 350 yards (320 meters) southeast of the target raft. The rocket was fired from Agerholm (Figure 79) and entered the water a few yards closer to the target raft along the line of fire.

Hopewell's speed was about 4 knots (7.4 km/hr). Equipment shown in Figure 78 but not listed in Table 17 were the unmanned Project 1.3 submarine simulators and the Project 1.1 sonobuoys. The submarine simulators were submerged from 50 to 100 feet (15 to 30 meters) and traveling as indicated by the dashed lines in Figure 78. The black dot at the end of each dashed line indicates the approximate position of each of the simulators at detonation time. The sonobuoys were positioned in a line due west of the target raft. The sonobuoys' general position is indicated by the wavy lines on the left of Figure 78. All ships except Hopewell were essentially stationary, with speeds of 1 knot (1.85 km/hr) or less.

About 40 seconds after the ASROC missile was launched, its nuclear depth bomb exploded. A small fraction of a second after the burst, the slick, a rapidly expanding ring of darkened water at the intersection of the expanding spherical shock wave and the water surface, became visible to aircraft over the surface zero. Initially the slick had a well-defined edge but became diffuse as the radius increased (Reference C.2001, p. 61). In less than 1 second, the spray dome appeared, and within about 6 seconds its radius was nearly 1,000 yards (914 meters) and the spray dome reached a height of almost 750 feet (229 meters) (Figure 80). Radial water plumes broke through the spray dome about 7 seconds after the burst, reaching a maximum height of about 2,100 feet (640 meters) in 16 seconds. The plumes were the first radioactive material to appear above the water surface. As the spray dome and plumes fell back toward the water's surface, they formed the base surge, a flat doughnut-shaped cloud moving outward from the point where the spray dome had broken the surface. The base surge consisted of small water droplets and was radioactive. About 110 seconds after the detonation, the base surge reached its maximum upwind and crosswind distance of about 2,000 yards (1.8 km) from surface zero. At that time it

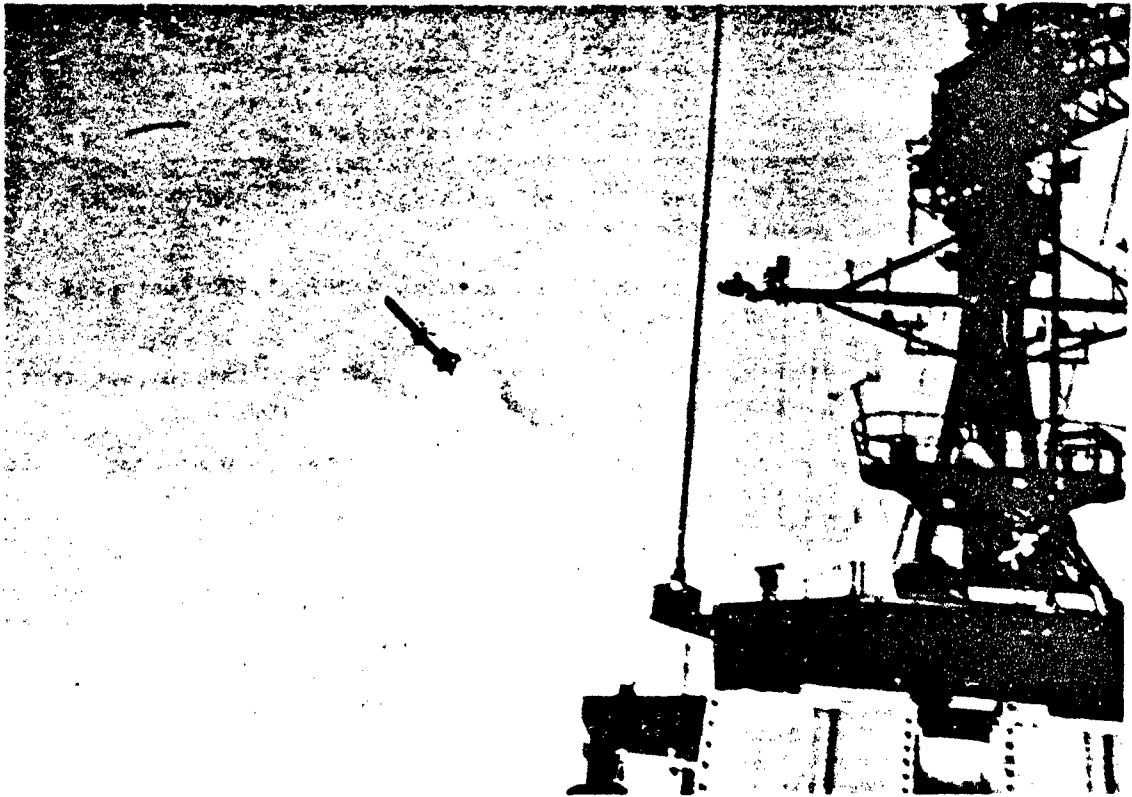


Figure 79. SWORDFISH ASROC missile launch from USS Agerholm (DD-826), Operation DOMINIC.



Figure 80. DOMINIC, SWORDFISH spray dome and plume with USS Agerholm (DD-826) in the foreground.

extended about 2,500 yards (2.3 km) downwind. The base surge remained visible for about 10 minutes, but it persisted as an invisible aerosol for at least 20 minutes (Figure 81). The foam patch visible on the surface as the base surge dispersed and evaporated had a radius of about 2,000 yards (1.8 km), about the same as the base surge except for its downwind extension. The foam patch remained visible from the air for several hours (Figure 82) (Reference C.1.D, pp. B-13 and B-16). Figure 83 is a plan view of the foam patch and base surge after 5 minutes.

Movements of Razorback, Agerholm, Anderson, and Hopewell for up to three-quarters of an hour after the shot are shown in Figure 84. Monticello and Molala moved very little. The upwind portion of the towed array, including Bausell, moved very little because it was still attached to Molala. The downwind portion of the towed array, consisting of a length of tow line and coracles 5, 6, 7, and 8, drifted southeast with the current. Coracle 4 and probably the target raft had become detached from the tow line. An RD5 aircraft from the Third Marine Air Wing apparently made the first effort to investigate the SWORDFISH radioactivity by flying over the pool of radioactive water at 3,000 feet (914 meters) 15 minutes after the shot. The radiation exposure rate "exceeded 50 r per hour." At 50 and 60 minutes after the shot, the aircraft flew over the pool at 1,500 feet (457 meters), detecting an exposure rate of 0.8 R/hr. Corrected for altitude attenuation, this does not correlate with the predicted values or those obtained by Sioux, but the record does not explain further. After returning to base at El Toro, California, the aircraft was monitored and no contamination was detected. The highest individual exposure reading among these crews was 0.149 R (Reference C.2007, p. 230).

Next to investigate the pool of radioactive water was Sioux, tasked, as part of Project 2.1, to collect water samples suitable for radiochemical analysis of the weapon's yield.

Preshot calculations by NRDL indicated the possibility of a radiation level of 1,000 R/hr near the surface of the pool 30 minutes postshot. Given certain assumptions about the mixing of the radioactive water with normal seawater, this level might decrease to 100 R/hr 1 hour after the shot and to 3 R/hr 2 hours after the shot. If the radiation level decreased at that rate, too long a delay in entering the pool could make it impossible to collect adequate water samples. Therefore, it was decided to approach the pool cautiously 30 minutes after the detonation (Reference D.5, Appendix 1, p. 2).

At 1310, with all personnel wearing protective clothing, all openings to the weather decks closed except two, and a variety of radiation detectors at the ready, Sioux, with crew reduced to 15, steamed toward the pool at 10 knots (18.5 km/hr). At 1318, with the pool about 2,000 yards (1.8 km) distant, the radiation level on the bridge began to rise from 0.0004 R/hr, and in the next few minutes, the rise accelerated. The ship's speed was 3 knots (5.6 km/hr). At 1321 the ship was at the edge of the pool. With the radiation reading on the starboard wing of the bridge at 0.300 R/hr and rising rapidly, the ship was advised to leave the pool. During the turning maneuver, the ship penetrated about 200 yards (183 meters) into the pool. The exposure rate rose to an estimated 1,000 R/hr, and one water sample was collected. Radiation levels decreased steadily as the ship proceeded away from the pool at flank speed, about 13 knots (24.1 km/hr) (Reference D.5, Appendix 1, pp. 3-4).



Figure 81. DOMINIC, SWORDFISH base surge. USS Preston (DD-715) and USS Agerholm (DD-826) are in center foreground, and USS Bausell (DD-845) is to the left.



Figure 82. DOMINIC, SWORDFISH foam patch at about 6 minutes after burst. View is from southeast of burst with USS Bausell in right background.

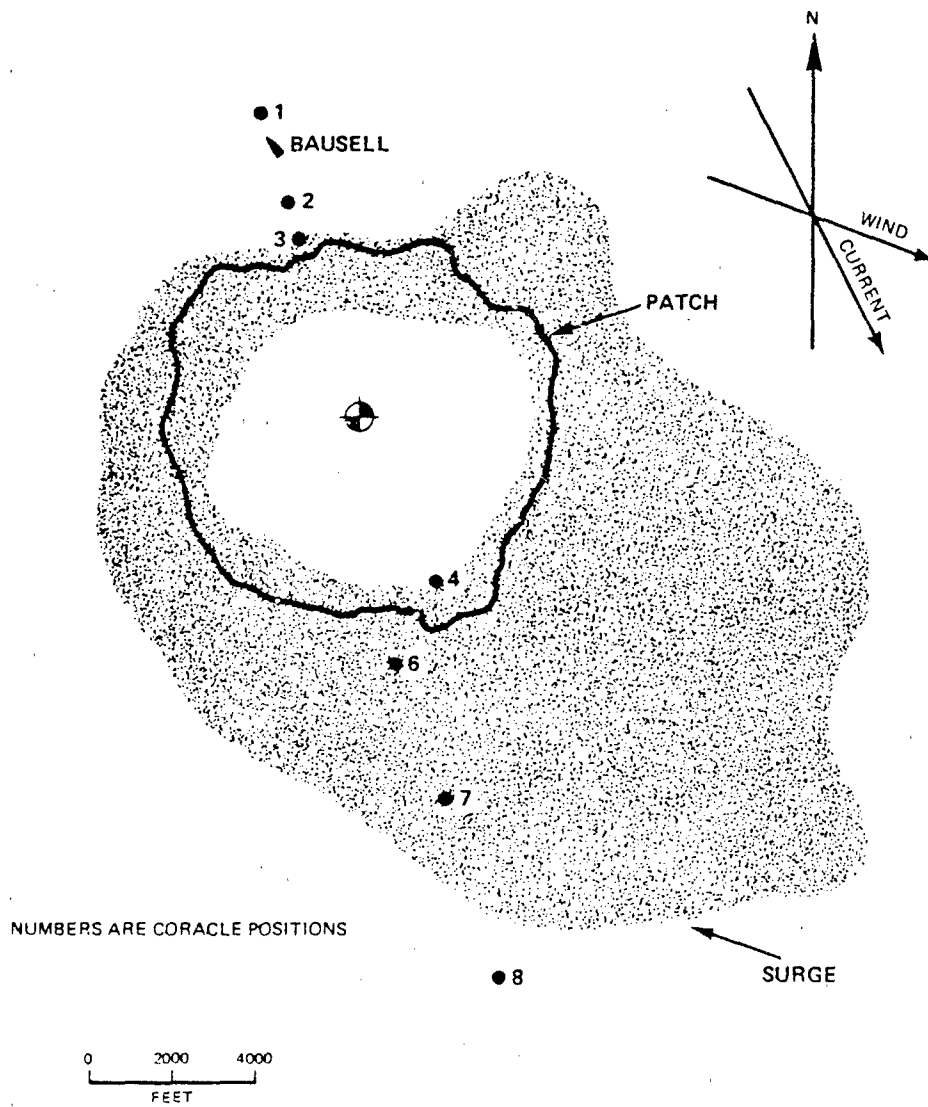


Figure 83. Position of DOMINIC, SWORDFISH foam patch and base surge 5 minutes after detonation (source: Reference C.2004, p. 61).

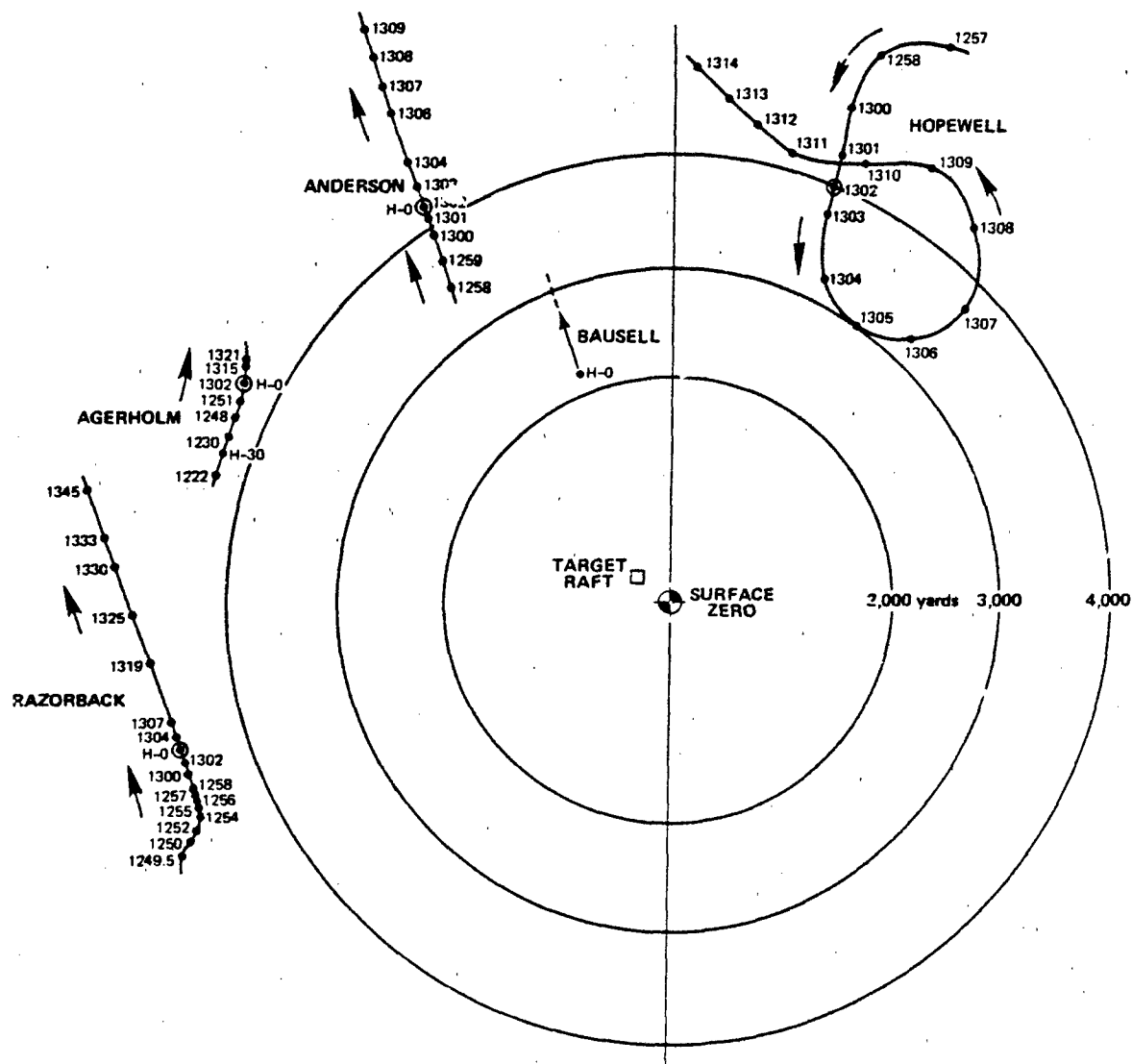


Figure 84. DOMINIC, SWORDFISH early postshot maneuvers of USS Razorback (SS-394), USS Agerholm (DD-826), USS Anderson (DD-786), and USS Hopewell (DD-822) (source: Reference C.2002, p. 36).

While within the pool, Sioux had encountered an invisible aerosol extending above the pool to a height of at least 30 feet (9.1 meters) (Reference C.2004, p. 45), leaving its weather decks with contamination that measured between 0.01 and 0.02 R/hr. The contamination on the weather decks was reduced by use of the washdown system. As of 1357, with the ship well clear of the pool, general radiation on the bridge was between 0.020 and 0.040 R/hr, but the source of that radiation is not made clear in the available documents (Reference D.5, Appendix 1, p. 4; Reference C.3.2, Sioux, 11 May 1962).

With only one sample of water collected and with nine of the personnel over or approaching the 3 R limit, the project officer requested an exposure waiver from CJTG 8.9. The limit was increased to 7 R (9 R according to one source), and by 1525 the ship had started another run at the pool. By 1553 high radiation levels were again encountered. By 1557 or shortly thereafter, the radiation level on the bridge rose to between 2 and 4 R/hr, implying a level in hundreds of roentgens per hour outside. Another water sample was taken, and Sioux departed the pool at best speed. No one aboard received more than 0.6 R during that run (Reference D.5, Appendix 1, pp. 6-7, Reference C.1.D, p. B-1-1).

Sioux collected a third water sample at 1710. Radiation in the bridge peaked at about 0.100 R, leading to an estimated exposure on the starboard wing well of between 1 and 10 R (Reference D.5, Appendix 1, p. 7).

The rest of Sioux's crew returned to the ship to replace the fifteen who had been aboard during the three incursions into the radioactive pool. AEC radiation monitors and NRDL personnel for the NRDL-AEC project came aboard with them. At 1808, the fifteen departed by boat to Monticello for decontamination. At least some of the crewmembers in exposed positions had shoes, hair, and hands contaminated up to 0.4 R/hr. Most personnel aboard Sioux probably did not have an opportunity to wash off their contamination before they left the ship for Monticello. They probably were accompanied by the three NRDL Project 2.1 personnel. The 15 crewmen returned to Sioux the next morning.

Following crew rotation, Sioux made an effort to track and map the pool to meet the objectives of the NRDL-AEC project, including the use of underwater detectors (Reference D.2, p. 21). At about 2300 on 11 May, the maximum exposure rate noted above the pool surface was 0.240 R/hr. Investigation of the pool for this project lasted until about 1300 on 12 May. The maximum exposure noted for all passes through the radioactive pool by Sioux for the NRDL-AEC project was 0.100 R (Reference C.2007, p. 232).

The ASROC overshot the target and consequently Baugell was farther from the surface zero than planned; therefore, the base surge did not reach the ship. Project personnel boarded the ship about an hour after the shot. It was not contaminated, even though the exposure rate on the fantail, the part of the ship closest to the detonation, had reached 44 R/hr shortly after the blast (Reference C.2007, p. 232; Reference C.1.D, p. B-18).

The target-array tow line had been parted, as planned, by an explosive charge on the upwind side of the target raft just before the ASROC launch. The two platforms (Projects 1.1 and 1.3), the first and second coracles (Project

D. OTHER REPORTS OF INTEREST

- D.1 Aerial Survey of the Surface Radioactivity Remaining After an Underwater Detonations***
E.J. Wesley, R. Cole, M.A. Olson, and W. F. Joseph
Naval Radiological Defense Laboratory
4 March 1963
- D.2 Early Dimensions and Radiation Intensities of the Radioactive Pool Resulting from Shot SWORDFISH***
T.H. Shirasawa
Naval Radiological Defense Laboratory
15 July 1964
- D.3 EG&G Participation Operation DOMINIC***
Edgerton, Germeshausen & Grier, Inc., 15 May 1963
- D.4 Operation SWORDFISH Project DUNC***
G.K. Riel
Naval Ordnance Laboratory
13 July 1962
- D.5 Rad-Safe Analysis of the Contaminated Water Environment at Early Times During Operation SWORDFISH, Appendix 1, The Saga of the Sioux (ATF-75), Appendix 2, Relative Size, Location and Radiation Levels of Contaminated Water from H+20 Minutes to H+24 Hours***
A.L. Baietti
22 May 1962
- D.6 Final Report, Radiochemical Diagnostic Measurements on the FRIGATE BIRD Event of Operation DOMINIC***
H.G. Hicks
Lawrence Radiation Laboratory
8 May 1968
- D.7 Radiochemical Diagnostic Measurements on the Harlem Event of Operation DOMINIC***
UCRL
22 June 1966 UCRL-14741
- D.8 Navy Film Badge Review: DOMINIC***
W.W. Perkins, R.R. Hammond
Naval Ocean systems Center
28 May 1980
- D.9 Not used

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.